

What is claimed is:

1. A crystalline composition comprising an amount of SiO_2 , Al_2O_3 , CaO , Fe_2O_3 , TiO_2 , K_2O , P_2O_5 , Cr_2O_3 , ZnO , MgO , Na_2O , Li_2O , CeO_2 , ZrO_2 and MnO_2 .

2. The crystalline composition of claim 1 further comprising an amount of 35.0 - 43.0 percent of SiO_2 , 29.0 - 36.0 percent of Al_2O_3 , 1.4 - 4.1 percent of Fe_2O_3 , 16.0 - 21.0 percent of CaO , 1.3 - 15.2 percent of TiO_2 , 0.6 - 8.9 percent of K_2O , 1.4 - 6.8 percent of P_2O_5 , 0 - 6.0 percent of Cr_2O_3 , 0 - 11.2 percent of ZnO , 0 - 1.5 percent of MnO_2 , 0 - 10.0 percent of MgO , 0 - 10.2 percent of Na_2O , 0 - 5.0 percent of CeO_2 , 0 - 5.0 percent of ZrO_2 and 0 - 10.2 percent of Li_2O by weight.

3. The crystalline composition of claim 1 further comprising an amount of 35.0 - 57.0 percent of SiO_2 , 15.0 - 36.0 percent of Al_2O_3 , 1.4 - 10.0 percent of Fe_2O_3 , 15.0 - 22.0 percent of CaO , 0.6 - 15.2 percent of TiO_2 , 0.3 - 11.0 percent of K_2O , 1.4 - 6.8 percent of P_2O_5 , 0 - 6.0 percent of Cr_2O_3 , 0 - 11.2 percent of ZnO , 0 - 11.5 percent of MnO_2 , 0 - 10.0 percent of MgO , 0 - 10.2 percent of Na_2O , 0 - 5.0 percent of CeO_2 , 0 - 5.0 percent of ZrO_2 and 0 - 10.2 percent of Li_2O by weight.

4. The poly-crystalline composition of claim 1, wherein the poly-crystalline composition is a non porous poly-crystalline composition.

5. The poly-crystalline composition of claim 1, wherein the density of the poly-crystalline composition is in the range of 2.5×10^3 to $2.9 \times 10^3 \text{ kg/m}^3$.

6. A poly-crystalline product comprising an amount of SiO_2 , Al_2O_3 , CaO , Fe_2O_3 , TiO_2 , K_2O , P_2O_5 , Cr_2O_3 , ZnO , MgO , Na_2O , Li_2O , CeO_2 , ZrO_2 and MnO_2 .

7. The poly-crystalline product of claim 6, further comprising an amount of 35.0 - 43.0 percent of SiO_2 , 29.0 - 36.0 percent of Al_2O_3 , 1.4 - 4.1 percent of Fe_2O_3 , 16.0 - 21.0 percent of CaO , 1.3 - 15.2 percent of TiO_2 , 0.6 - 8.9 percent of K_2O , 1.4 - 6.8 percent of P_2O_5 , 0 - 6.0 percent of Cr_2O_3 , 0 - 11.2 percent of ZnO , 0 - 1.5 percent of MnO_2 , 0 - 10.0 percent of MgO , 0 - 10.2 percent of Na_2O , 0 - 5.0 percent of CeO_2 , 0 - 5.0 percent of ZrO_2 and 0 - 10.2 percent of Li_2O by weight.

8. The crystalline product of claim 6, further comprising an amount of 35.0 - 57.0 percent of SiO_2 , 15.0 - 36.0 percent of Al_2O_3 , 1.4 - 10.0 percent of Fe_2O_3 , 15.0 - 22.0 percent of CaO , 0.6 - 15.2 percent of TiO_2 , 0.3 - 11.0 percent of K_2O , 1.4 - 6.8 percent of P_2O_5 , 0 - 6.0 percent of Cr_2O_3 , 0 - 11.2 percent of ZnO , 0 - 11.5 percent of MnO_2 , 0 - 10.0 percent of MgO , 0 - 10.2 percent of Na_2O , 0 - 5.0 percent of CeO_2 , 0 - 5.0 percent of ZrO_2 and 0 - 10.2 percent of Li_2O by weight.

9. The poly-crystalline product of claim 6, wherein the poly-crystalline product is a non porous poly-crystalline product.

10. The poly-crystalline product of claim 6, wherein the density of the poly-crystalline composition is in the range of 2.5×10^3 to $2.9 \times 10^3 \text{ kg/m}^3$.

5 11. A process for producing a poly-crystalline composition comprising the steps of:

a. Mixing an ash particle with at least one glass forming agent and at least one crystallization catalyst,

10 b. Melting said ash particle, said at least one glass forming agent and said at least one crystallization catalyst to form a mixture; and

c. Cooling the resulting mixture to ambient temperature so as to form a homogenous, non-porous poly-crystalline product comprising SiO_2 , Al_2O_3 , CaO , Fe_2O_3 , TiO_2 , K_2O , P_2O_5 , Cr_2O_3 , ZnO , MgO , Na_2O , Li_2O , CeO_2 , ZrO_2 and MnO_2 .

12. The process of claim 11; wherein in step C the poly-crystalline product further
15 comprising an amount of 35.0 - 43.0 percent of SiO_2 , 29.0 - 36.0 percent of Al_2O_3 , 1.4 - 4.1 percent of Fe_2O_3 , 16.0 - 21.0 percent of CaO , 1.3 - 15.2 percent of TiO_2 , 0.6 - 8.9 percent of K_2O , 1.4 - 6.8 percent of P_2O_5 , 0-1.5 percent of Cr_2O_3 , 0 - 11.2 percent of ZnO , 0 - 1.5 percent of MnO_2 , 0 - 10.0 percent of MgO , 0 - 10.2 percent of Na_2O , 0 - 5.0 percent of CeO_2 , 0 - 5.0 percent of ZrO_2 and 0 - 10.2 percent of Li_2O by
20 weight.

13. The process of claim 11, wherein in step C the poly-crystalline product further comprising an amount of 35.0 - 57.0 percent of SiO_2 , 15.0 - 36.0 percent of Al_2O_3 , 1.4 - 10.0 percent of Fe_2O_3 , 15.0 - 22.0 percent of CaO , 0.6 - 15.2 percent of TiO_2 , 0.3 - 11.0 percent of K_2O , 1.4 - 6.8 percent of P_2O_5 , 0 - 6.0 percent of Cr_2O_3 , 0 - 11.2
25 percent of ZnO , 0 - 11.5 percent of MnO_2 , 0 - 10.0 percent of MgO , 0 - 10.2 percent of Na_2O , 0 - 5.0 percent of CeO_2 , 0 - 5.0 percent of ZrO_2 and 0 - 10.2 percent of Li_2O by weight.

14. The process of claim 11, wherein said at least one glass forming agent is selected from the group consisting of SiO_2 , Al_2O_3 , Li_2O , MgO , Na_2O , CaO and K_2O .

30 15. The process of claim 11, wherein said at least one crystallization catalyst is selected from the group consisting of titanium dioxide, chromium oxide, zinc oxide, cerium dioxide, manganese dioxide and zirconium dioxide.

16. The process of claim 11, wherein in step B the ash particle, the at least one glass forming agent and the at least one crystallization catalyst are heated at the temperature range of 1400°C - 1600°C.

17. An article of manufacture comprising SiO₂, Al₂O₃, CaO, Fe₂O₃, TiO₂, K₂O, P₂O₅, Cr₂O₃, ZnO, MgO, Na₂O, Li₂O, CeO₂, ZrO₂ and MnO₂.

18. The article of manufacture of claim 17, further comprising an amount of 35.0 - 43.0 percent of SiO₂, 29.0 - 36.0 percent of Al₂O₃, 1.4 - 4.5 percent of Fe₂O₃, 6.0 - 25.0 percent of CaO, 1.3 - 15.2 percent of TiO₂, 0.6 - 8.9 percent of K₂O, 1.4 - 6.8 percent of P₂O₅, 0 - 6.0 percent of Cr₂O₃, 0 - 5.2 percent of ZnO, 0 - 5.5 percent of MnO₂, 0 - 10.0 percent of MgO, 0 - 10.2 percent of Na₂O, 0 - 5.0 percent of CeO₂, 0 - 5.0 percent of ZrO₂ and 0 - 10.2 percent of Li₂O by weight.

18. The article of manufacture of claim 17, further comprising an amount of 35.0 - 57.0 percent of SiO₂, 15.0 - 36.0 percent of Al₂O₃, 1.4 - 10.0 percent of Fe₂O₃, 15.0 - 22.0 percent of CaO, 0.6 - 15.2 percent of TiO₂, 0.3 - 11.0 percent of K₂O, 1.4 - 6.8 percent of P₂O₅, 0 - 6.0 percent of Cr₂O₃, 0 - 11.2 percent of ZnO, 0 - 11.5 percent of MnO₂, 0 - 10.0 percent of MgO, 0 - 10.2 percent of Na₂O, 0 - 5.0 percent of CeO₂, 0 - 5.0 percent of ZrO₂ and 0 - 10.2 percent of Li₂O by weight.

19. The article of manufacture of claim 17, wherein the article of manufacture is a non-porous article of manufacture.

20. The article of manufacture of claim 17, wherein the density of the article of manufacture is in the range of 2.5×10^3 to 2.9×10^3 kg/m³.

21. A poly-crystalline product that is produced by a process comprising the steps of:

a. Mixing ash particle with at least one glass forming agent and at least one crystallization catalyst,

b. Melting said ash particle, said at least one glass forming agent and said at least one crystallization catalyst to form a mixture; and

c. Cooling the resulting mixture to ambient temperature to form a homogenous, non-porous microcrystalline composition comprising SiO₂, Al₂O₃, CaO, Fe₂O₃, TiO₂, K₂O, P₂O₅, Cr₂O₃, ZnO, MgO, Na₂O, Li₂O, CeO₂, ZrO₂ and MnO₂.

22. The poly-crystalline product of claim 21, wherein in step C said microcrystalline composition further comprising an amount of 35.0-43.0 percent of SiO₂, 29.0 - 36.0 percent of Al₂O₃, 1.4 - 4.1 percent of Fe₂O₃, 16.0 - 21.0 percent of CaO, 1.3 - 15.2 percent of TiO₂, 0.6 - 8.9 percent of K₂O, 1.4 - 6.8 percent of P₂O₅, 0

- 6.0 percent of Cr_2O_3 , 0 - 11.2 percent of ZnO , 0 - 1.5 percent of MnO_2 , 0 - 10.0 percent of MgO , 0 - 10.2 percent of Na_2O , 0 - 5.0 percent of CeO_2 , 0 - 5.0 percent of ZrO_2 and 0 - 10.2 percent of Li_2O by weight.

23. The poly-crystalline product of claim 21, wherein in step C said microcrystalline composition further comprising an amount of 35.0 - 57.0 percent of SiO_2 , 15.0 - 36.0 percent of Al_2O_3 , 1.4 - 10.0 percent of Fe_2O_3 , 15.0 - 22.0 percent of CaO , 0.6 - 15.2 percent of TiO_2 , 0.3 - 11.0 percent of K_2O , 1.4 - 6.8 percent of P_2O_5 , 0 - 6.0 percent of Cr_2O_3 , 0 - 11.2 percent of ZnO , 0 - 11.5 percent of MnO_2 , 0 - 10.0 percent of MgO , 0 - 10.2 percent of Na_2O , 0 - 5.0 percent of CeO_2 , 0 - 5.0 percent of ZrO_2 and 0 - 10.2 percent of Li_2O by weight.

24. The poly-crystalline product of claim 21, wherein the density of the poly-crystalline composition is in the range of 2.5×10^3 to $2.9 \times 10^3 \text{ kg/m}^3$.

25. The poly-crystalline product of claim 21; wherein the poly-crystalline product is a non-porous poly-crystalline product.

26. The poly-crystalline product of claim 21, wherein said at least one glass is selected from the group consisting of SiO_2 , Al_2O_3 , Li_2O , MgO , Na_2O , CaO , K_2O .

27. The poly-crystalline product of claim 21, wherein said at least one crystallization catalyst is selected from the group consisting of titanium dioxide, chromium oxide, zinc oxide, cerium dioxide, manganese dioxide and zirconium dioxide.

28. The poly-crystalline product of claim 21, wherein in step B said ash particle, said at least one glass forming agent and said at least one crystallization catalyst are heated at the temperature range of 1400°C - 1600°C .

32. The poly-crystalline product of claim 21; wherein said fly ash particle is about 25-90 percent, said glass forming agent is about 5-70 percent and said crystallization catalyst is about 0-15 percent on a dry basis of the poly-crystalline product.